HW 17 Buoyant Force

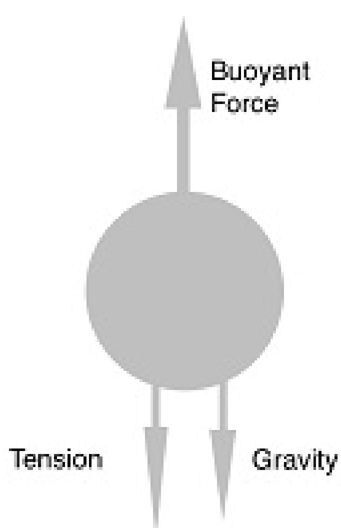
A beaker weighing 2.0 N is filled with $5.0 \times 10^{-3} m^3$ of water. A rubber ball weighing 3.0 N is held entirely underwater by a massless string attached to the bottom of the beaker, as represented in the figure. The tension in the string is 4.0 N. The water fills the beaker to a depth of 0.20 m. Water has a density of $1000 kg/m^3$. The effects of atmospheric pressure may be neglected.

a) Calculate the weight of the entire apparatus.

Beaker + Ball + Water = Total Weight

$2N + 3N + 0.005m^3(1000kg/m^3)(9.8m/s^2) = \boxed{54N}$

b) On the dot below that represents the ball, draw and label the forces (not components) that act on the ball.



c) Calculate the buoyant force exerted on the ball by the water. If you need to draw anything other than what you have shown in part (b) to assist in your solution, use the space below. Do NOT add anything to the figure in part (b).

$\sum F = ma$

$F_b - F_g - T = 0$

$F_b = F_g + T$

$F_b = 3N + 4N$

$F_b = \boxed{7N}$

d) Calculate the pressure due to the liquid (the gauge pressure) at the bottom of the beaker.

$p_{gauge} = \rho g h$

$P_{gauge} = (1000kg/m^3)(9.8m/s^2)(0.2m)$

$P_{gauge} = 1960Pa$

(e) The string is cut, and the ball rises to the surface and floats. Indicate whether the water level is higher, lower, or the same after equilibrium is reached.

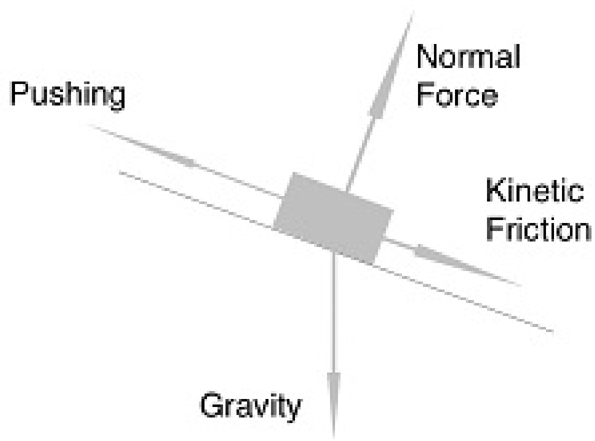
$\boxed{lower}$

Justify your answer.

Knowing that the ball floats to the top, we can deduce that the ball is less dense that the water. At equilibrium, the ball will be floating at the top, and therefore will be displacing less water. This means that the water level will drop.

A box is being pushed at constant speed up an inclined plane to a vertical height of 3.0 m above the ground, as shown in the figure. The person exerts a force parallel to the plane. The mass m of the box is 50 kg, and the coefficient of friction μ_k between the box and the plane is 0.30.

a) On the dot below that represents the box, draw and label the forces (not components) acting on the box.



b) Calculate the normal force of the plane on the box. If you need to draw anything other than what you have shown in part (a) to assist in your solution, use the space below. Do NOT add anything to the figure in part (a).

$$F_y = F_n$$

$$F_n = mg\cos 20^o$$

$$F_n = (50Kg)(9.8m/s^2)\cos 20^o$$

$$F_n = \boxed{460.45N}$$

c) Calculate the component of the force of gravity acting on the box that is parallel to the plane.

$$F_x = mg\sin 20^o$$

$$F_x = (50Kg)(9.8m/s^2)\sin 20^o$$

$$F_x = \boxed{167.59N}$$

d) Calculate the friction force between the plane and the box.

$$F_f = \mu_k F_n = (0.3)460.45N = \boxed{138.135N}$$

e) Calculate the force applied by the person on the box.

$$\sum F = ma$$

$$\sum F = 0$$

$$F_p - F_x - F_f = 0$$

$$F_p = F_x + F_f$$

$$F_p = 167.59N + 138.135N = \boxed{305.725N}$$

f) Calculate the work done by the person pushing the box, assuming the box is raised to the vertical height of 3.0 m.

$$\sin 20^o = \frac{3}{d}$$

$$d = 8.77m$$

$$W = F \cdot d$$

$$W = 305.725N \cdot 8.77m = \boxed{2681.64J}$$